

Annie Murphy Paul: What we learn before we're born: TED Talk

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Well today I want to present to you an idea that may be surprising and may even seem implausible, but which is supported by the latest evidence from psychology and biology. And that is that some of the most important learning we ever do happens before we're born, while we're still in the womb. Now I'm a science reporter. I write books and magazine articles. And I'm also a mother. And those two roles came together for me in a book that I wrote called "Origins." "Origins" is a report from the front lines of an exciting new field called fetal origins. Fetal origins is a scientific discipline that emerged just about two decades ago, and it's based on the theory that our health and well-being throughout our lives is crucially affected by the nine months we spend in the womb. Now this theory was of more than just intellectual interest to me. I was myself pregnant while I was doing the research for the book. And one of the most fascinating insights I took from this work is that we're all learning about the world even before we enter it.

When we hold our babies for the first time, we might imagine that they're clean slates, unmarked by life, when in fact, they've already been shaped by us and by the particular world we live in. Today I want to share with you some of the amazing things that scientists are discovering about what fetuses learn while they're still in their mothers' bellies.

First of all, they learn the sound of their mothers' voices. Because sounds from the outside world have to travel through the mother's abdominal tissue and through the amniotic fluid that surrounds the fetus, the voices fetuses hear, starting around the fourth month of gestation, are muted and muffled. One researcher says that they probably sound a lot like the voice of Charlie Brown's teacher in the old "Peanuts" cartoon. But the pregnant woman's own voice reverberates through her body, reaching the fetus much more readily. And because the fetus is with her all the time, it hears her voice a lot. Once the baby's born, it recognizes her voice and it prefers listening to her voice over anyone else's.

How can we know this? Newborn babies can't do much, but one thing they're really good at is sucking. Researchers take advantage of this fact by rigging up two rubber nipples, so that if a baby sucks on one, it hears a recording of its mother's voice on a pair of headphones, and if it sucks on the other nipple, it hears a recording of a female stranger's voice. Babies quickly show their preference by choosing the first one. Scientists also take advantage of the fact that babies will slow down their sucking when something interests them and resume their fast sucking when they get bored. This is how researchers discovered that, after women repeatedly read aloud a section of Dr. Seuss' "The Cat in the Hat" while they were pregnant, their newborn babies recognized that passage when they hear it outside the womb. My favorite experiment of this kind is the one that showed that the babies of women who watched a certain soap opera every day during pregnancy recognized the theme song of that show once they were born. So fetuses are even learning about the particular language that's spoken in the world that they'll be born into.

A study published last year found that from birth, from the moment of birth, babies cry in the accent of their mother's native language. French babies cry on a rising note while German babies end on a falling note, imitating the melodic contours of those languages. Now why would this kind of fetal learning be useful? It may have evolved to aid the baby's survival. From the moment of birth, the baby responds most to the voice of the person who is most likely to care for it --its mother. It even makes its cries sound like the mother's language, which may further endear the baby to the mother, and which may give the baby a head start in the critical task of learning how to understand and speak its native language.

But it's not just sounds that fetuses are learning about in utero. It's also tastes and smells. By seven months of gestation, the fetus' taste buds are fully developed, and its olfactory receptors, which allow it to smell, are functioning. The flavors of the food a pregnant woman eats find their way into the amniotic fluid, which is continuously swallowed by the fetus. Babies seem to remember and prefer these tastes once they're out in the world. In one experiment, a group of pregnant women was asked to drink a lot of carrot juice during their third trimester of pregnancy, while another group of pregnant women drank only water. Six months later, the women's infants were offered cereal mixed with carrot juice, and their facial expressions were observed while they ate it. The offspring of the carrot juice drinking women ate more carrot-flavored cereal, and from the looks of it, they seemed to enjoy it more.

A sort of French version of this experiment was carried out in Dijon, France where researchers found that mothers who consumed food and drink flavored with licorice-flavored anise during pregnancy showed a preference for anise on their first day of life, and again, when they were tested later, on their fourth day of life. Babies whose mothers did not eat anise during pregnancy showed a reaction that translated roughly as "yuck." What this means is that fetuses are effectively being taught by their mothers about what is safe and good to eat. Fetuses are also being taught about the particular culture that they'll be joining through one of culture's most powerful expressions, which is food. They're being introduced to the characteristic flavors and spices of their culture's cuisine even before birth.

Now it turns out that fetuses are learning even bigger lessons .But before I get to that ,I want to address something that you may be wondering about. The notion of fetal learning may conjure up for you attempts to enrich the fetus --like playing Mozart through headphones placed on a pregnant belly. But actually, the nine-month-long process of molding and shaping that goes on in the womb is a lot more visceral and consequential than that. Much of what a pregnant woman encounters in her daily life --the air she breathes, the food and drink she consumes, the chemicals she's exposed to, even the emotions she feels --are shared in some fashion with her fetus. They make up a mix of influences as individual and idiosyncratic as the woman herself. The fetus incorporates these offerings into its own body, makes them part of its flesh and blood. And often it does something more. It treats these maternal contributions as information, as what I like to call biological postcards from the world outside.

So what a fetus is learning about in utero is not Mozart's "Magic Flute" but answers to questions much more critical to its survival. Will it be born into a world of abundance or scarcity? Will it be safe and protected, or will it face constant dangers and threats? Will it live a long, fruitful life or a short, harried one? The pregnant woman's diet and stress level in particular provide important clues to prevailing conditions like a finger lifted to the wind. The resulting tuning and tweaking of a fetus' brain and other organs are part of what give us humans our enormous flexibility, our ability to thrive in a huge variety of environments, from the country to the city, from the tundra to the desert.

To conclude, I want to tell you two stories about how mothers teach their children about the world even before they're born. In the autumn of 1944, the darkest days of World War II, German troops blockaded Western Holland, turning away all shipments of food. The opening of the Nazi's siege was followed by one of the harshest winters in decades --so cold the water in the canals froze solid. Soon food became scarce, with many Dutch surviving on just 500 calories a day --a quarter of what they consumed before the war. As weeks of deprivation stretched into months, some resorted to eating tulip bulbs. By the beginning of May, the nation's carefully rationed food reserve was completely exhausted. The specter of mass starvation loomed. And then on May 5th, 1945, the siege came to a sudden end when Holland was liberated by the Allies.

The "Hunger Winter," as it came to be known, killed some 10,000 people and weakened thousands more. But there was another population that was affected --the 40,000 fetuses in utero during the siege. Some of the effects of malnutrition during pregnancy were immediately apparent in higher rates of stillbirths, birth defects, low birth weights and infant mortality. But others wouldn't be discovered for many years. Decades after the "Hunger Winter," researchers documented that people whose mothers were pregnant during the siege have more obesity, more diabetes and more heart disease in later life than individuals who were gestated under normal conditions. These individuals' prenatal experience of starvation seems to have changed their bodies in myriad ways. They have higher blood pressure, poorer cholesterol profiles and reduced glucose tolerance --a precursor of diabetes.

Why would under nutrition in the womb result in disease later? One explanation is that fetuses are making the best of a bad situation. When food is scarce, they divert nutrients towards the really critical organ, the brain, and away from other organs like the heart and liver. This keeps the fetus alive in the short-term, but the bill comes due later on in life when those other organs, deprived early on, become more susceptible to disease. But that may not be all that's going on. It seems that fetuses are taking cues from the intrauterine environment and tailoring their physiology accordingly. They're preparing themselves for the kind of world they will encounter on the other side of the womb. The fetus adjusts its metabolism and other physiological processes in anticipation of the environment that awaits it. And the basis of the fetus' prediction is what its mother eats. The meals a pregnant woman consumes constitute a kind of story, a fairy tale of abundance or a grim chronicle of deprivation. This story imparts information that the fetus uses to organize its body and its systems --an adaptation to prevailing circumstances

that facilitates its future survival. Faced with severely limited resources, a smaller-sized child with reduced energy requirements will, in fact, have a better chance of living to adulthood.

The real trouble comes when pregnant women are, in a sense, unreliable narrators, when fetuses are led to expect a world of scarcity and are born instead into a world of plenty. This is what happened to the children of the Dutch "Hunger Winter." And their higher rates of obesity, diabetes and heart disease are the result. Bodies that were built to hang onto every calorie found themselves swimming in the superfluous calories of the post-war Western diet. The world they had learned about while in utero was not the same as the world into which they were born.

Here's another story. At 8:46 a.m. on September 11th, 2001, there were tens of thousands of people in the vicinity of the World Trade Center in New York --commuters spilling off trains, waitresses setting tables for the morning rush, brokers already working the phones on Wall Street. 1,700 of these people were pregnant women. When the planes struck and the towers collapsed, many of these women experienced the same horrors inflicted on other survivors of the disaster --the overwhelming chaos and confusion, the rolling clouds of potentially toxic dust and debris, the heart-pounding fear for their lives.

About a year after 9/11, researchers examined a group of women who were pregnant when they were exposed to the World Trade Center attack. In the babies of those women who developed post-traumatic stress syndrome, or PTSD, following their ordeal, researchers discovered a biological marker of susceptibility to PTSD --an effect that was most pronounced in infants whose mothers experienced the catastrophe in their third trimester. In other words, the mothers with post-traumatic stress syndrome had passed on a vulnerability to the condition to their children while they were still in utero.

Now consider this: post-traumatic stress syndrome appears to be a reaction to stress gone very wrong, causing its victims tremendous unnecessary suffering. But there's another way of thinking about PTSD. What looks like pathology to us may actually be a useful adaptation in some circumstances. In a particularly dangerous environment, the characteristic manifestations of PTSD --a hyper-awareness of one's surroundings, a quick-trigger response to danger --could save someone's life. The notion that the prenatal transmission of PTSD risk is adaptive is still speculative, but I find it rather poignant. It would mean that, even before birth, mothers are warning their children that it's a wild world out there, telling them, "Be careful."

Let me be clear. Fetal origins research is not about blaming women for what happens during pregnancy. It's about discovering how best to promote the health and well-being of the next generation. That important effort must include a focus on what fetuses learn during the nine months they spend in the womb. Learning is one of life's most essential activities, and it begins much earlier than we ever imagined.

Thank you.

(Applause)